Mapping and Predictive Modeling of the Invasive Weed Leafy Spurge

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Alien Nation

- Estimated 50,000 species have entered North America over the last 400 years.
- Vast majority don't survive – ultimately displaced by natives.
- Others settle into easy citizenship and cause significant economic damage.
- Nonindigenous species caused more than **$124 BILLION** in damage in the U.S. last year.
- Invasive species are regarded as a significant threat to endangered species.

Major Culprits

Asian Longhorned Beetle
1996
$14 MILLION

Red Imported Fire Ant
1919
$1 BILLION

Africanized Honey Bee
1990
$Undetermined

Formosan Termite
1965
$1 BILLION

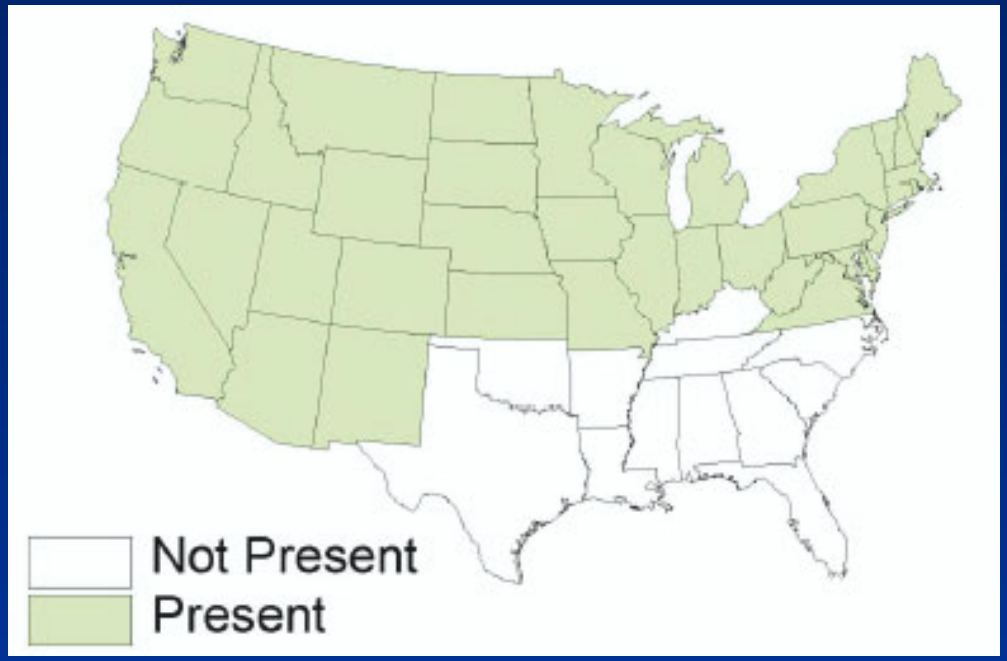
Zebra Mussel
1988
$5 BILLION

Leafy Spurge (*Euphorbia esula* L.)

Leafy Spurge Adaptations

Leafy Spurge the Invasive

- ✓ Introduced to Northeastern North America in late 1820s
- ✓ Reached west coast of N.A. by early 1900s
- ✓ High genetic variability leads to adaptations to local growing conditions



USDA-NRCS. 1999. The PLANTS database (http://plants.usda.gov/plants).
National Plant Data Center, Baton Rouge, LA 70874-4490 USA.

- Thrives in disturbed areas, especially pastures, rangelands, roadsides, waste areas, abandoned cropland, etc.
- Displaces native grasses & carrying capacity of rangeland for cattle by 50-75%
- Heavily infested areas are 100% loss to ranchers
- Today found throughout much of N.A. (every county in ND)

Prairie Fringed Orchid

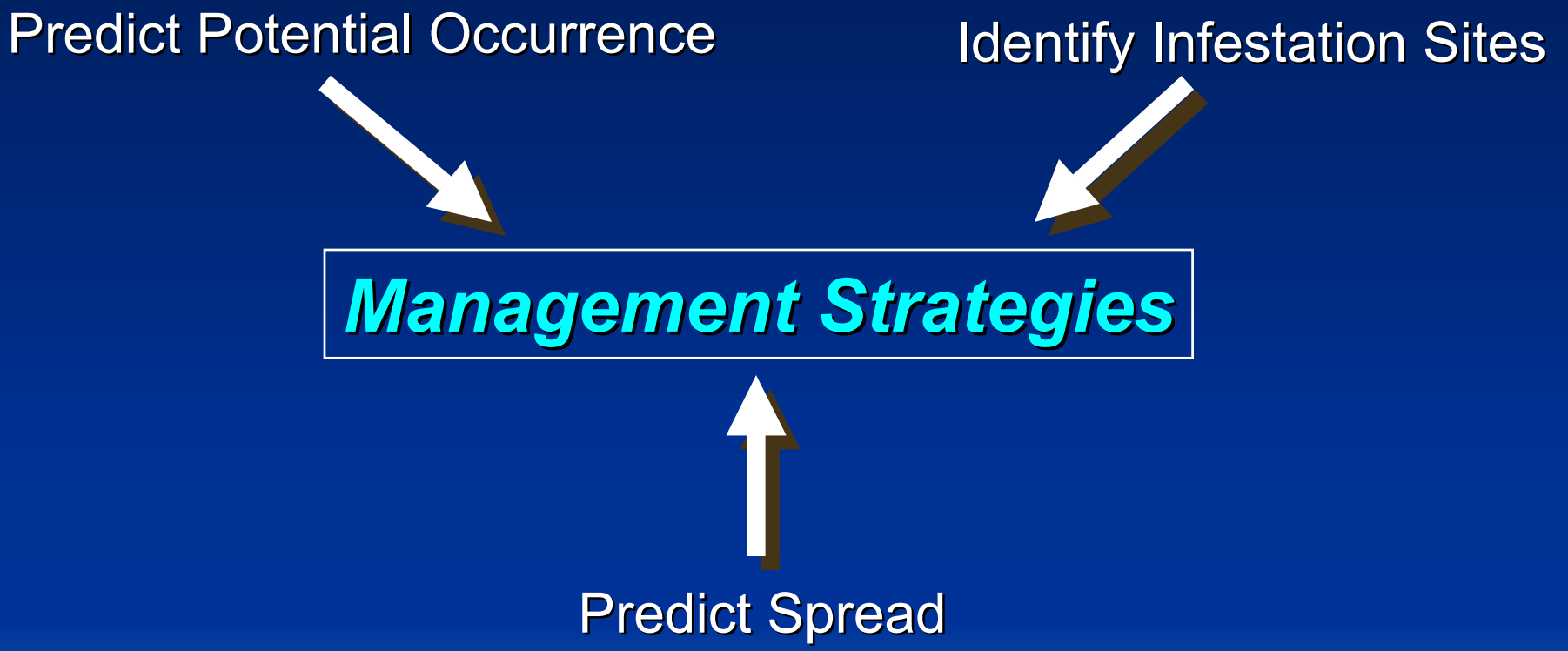
Financial Impact

- More than 3.0 million acres infested (as of 1997)
  - ✓ loss of plant diversity
  - ✓ loss of wildlife forage & habitat
- In North Dakota, more than $15 million in economic losses (more than $200 million nationally)
  - ✓ reduced forage production and use
  - ✓ control costs
- No grazing in areas with greater than 10-20% coverage
- Significantly decreased land values
- Good forage for sheep, goats and possibly buffalo

Management Strategies

- Prevention – stop human movement of seeds
- Grazing – sheep & goats coupled with a careful reseeding program
- Physical Control – tillage programs (growing season & fall-only cultivation)
- Chemical Control – annual applications of herbicides; esp. useful with small, isolated patches (Picloram + 2,4-D probably most effective)
- Biological Control – will not eradicate, but greatly reduce populations

Problem/Challenge



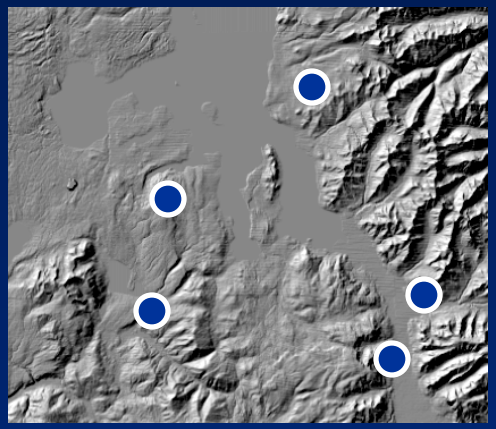
Reliable methods that identify and predict the spread of leafy spurge would greatly enhance the management strategies used to control this weed.

Materials & Methods

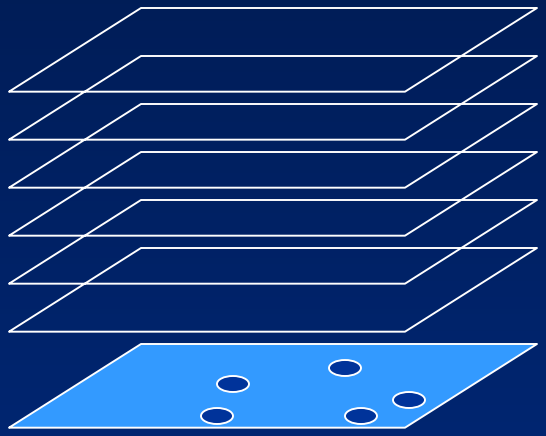
Predictive Distributional Modeling

- Modeling the Fundamental Ecological Niche
- GARP (Genetic Algorithm for Rule-Set Prediction) – an iterative, artificial-intelligence-based approach
- Identifies correlations between a species distribution and the environmental characteristics of the given area
- 187 environmental layers used (climatic, soil, vegetative variables)

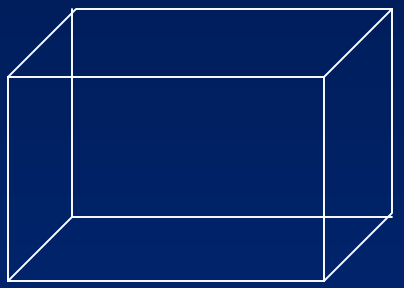
Ecological Niche Modeling



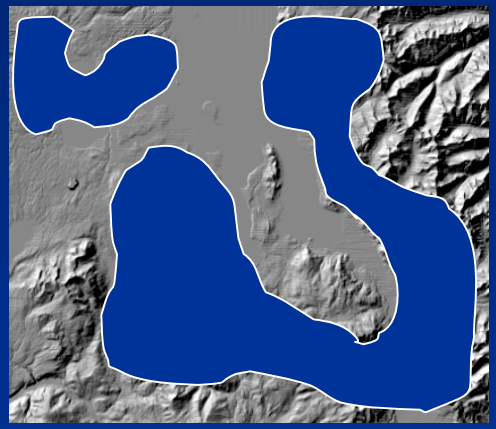
Point-locality data



Environmental overlays



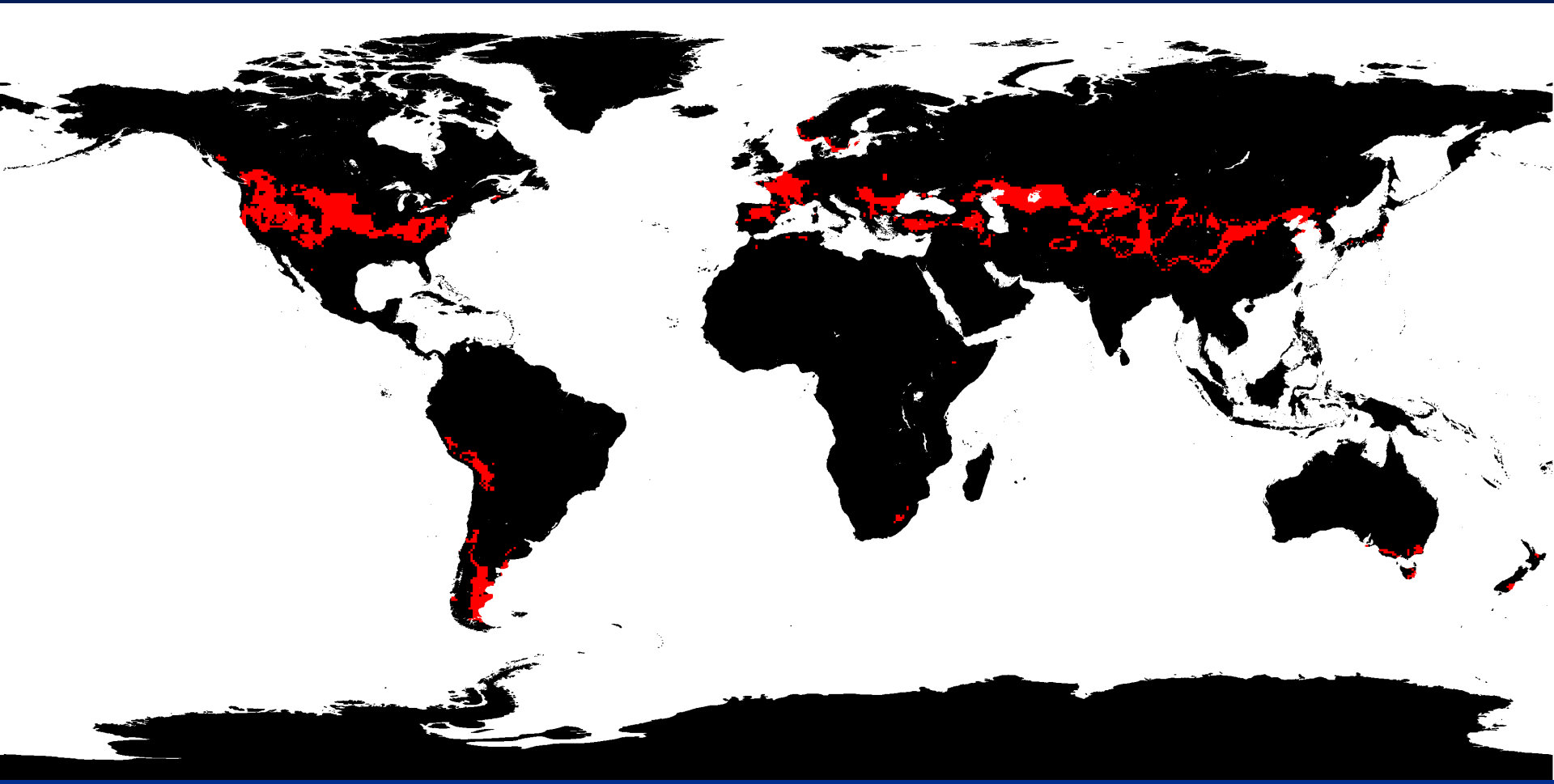
Niche model *n*-dimensional



Predictive distribution

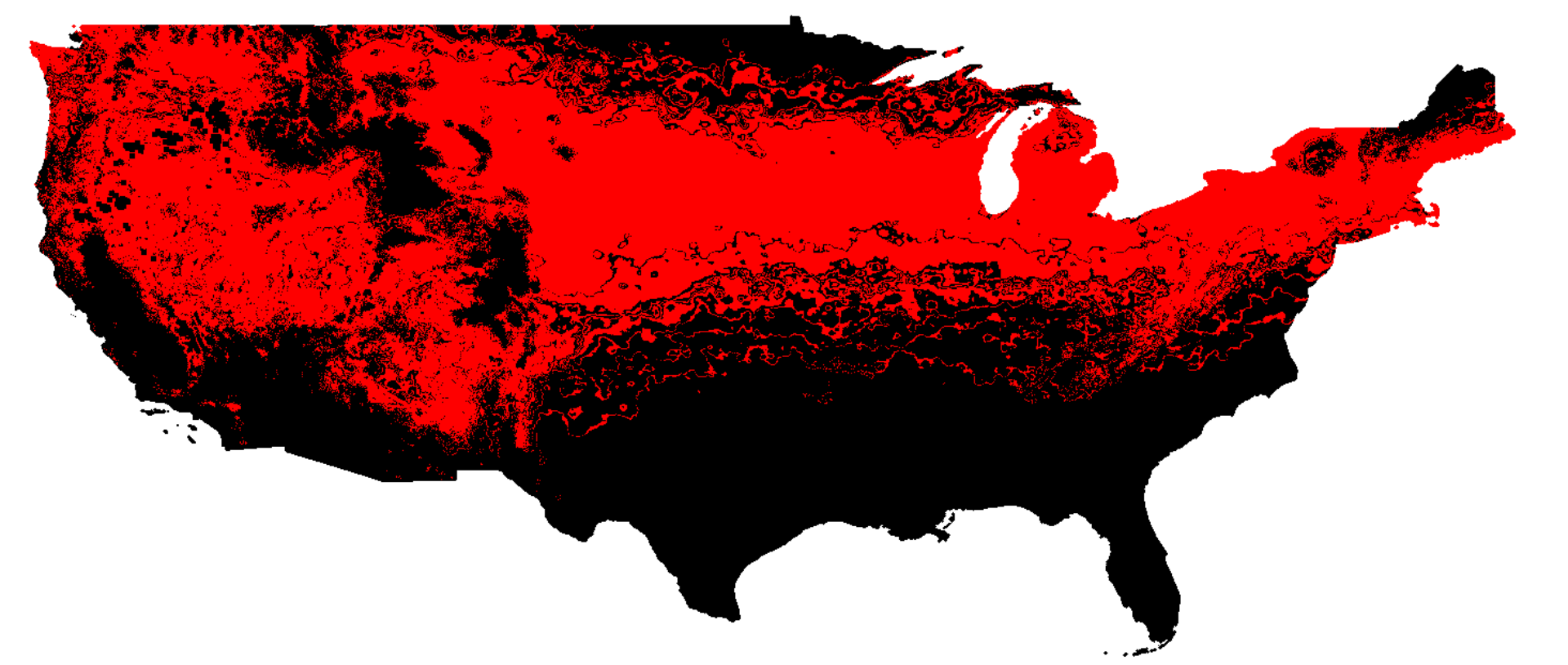
- Predictive distributional modeling
- Accuracy assessments

Suitable Habitat



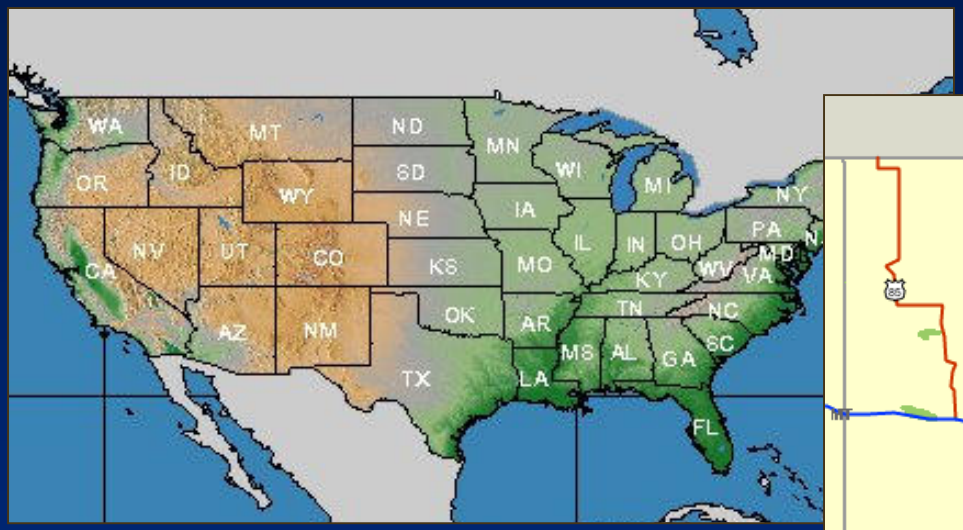
Predictive Distributional Model – 16 environmental variables

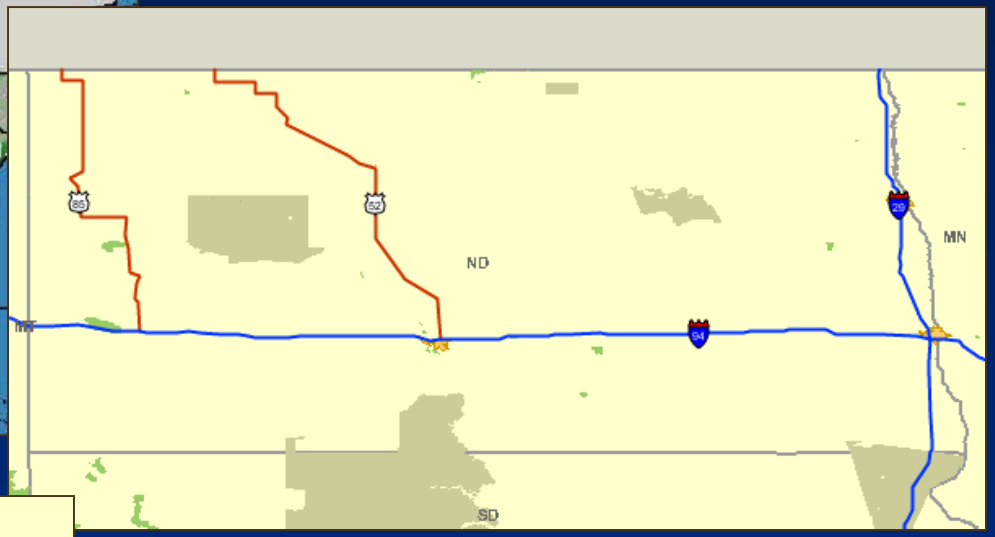
Leafy Spurge Predictive Model



187 environmental variables

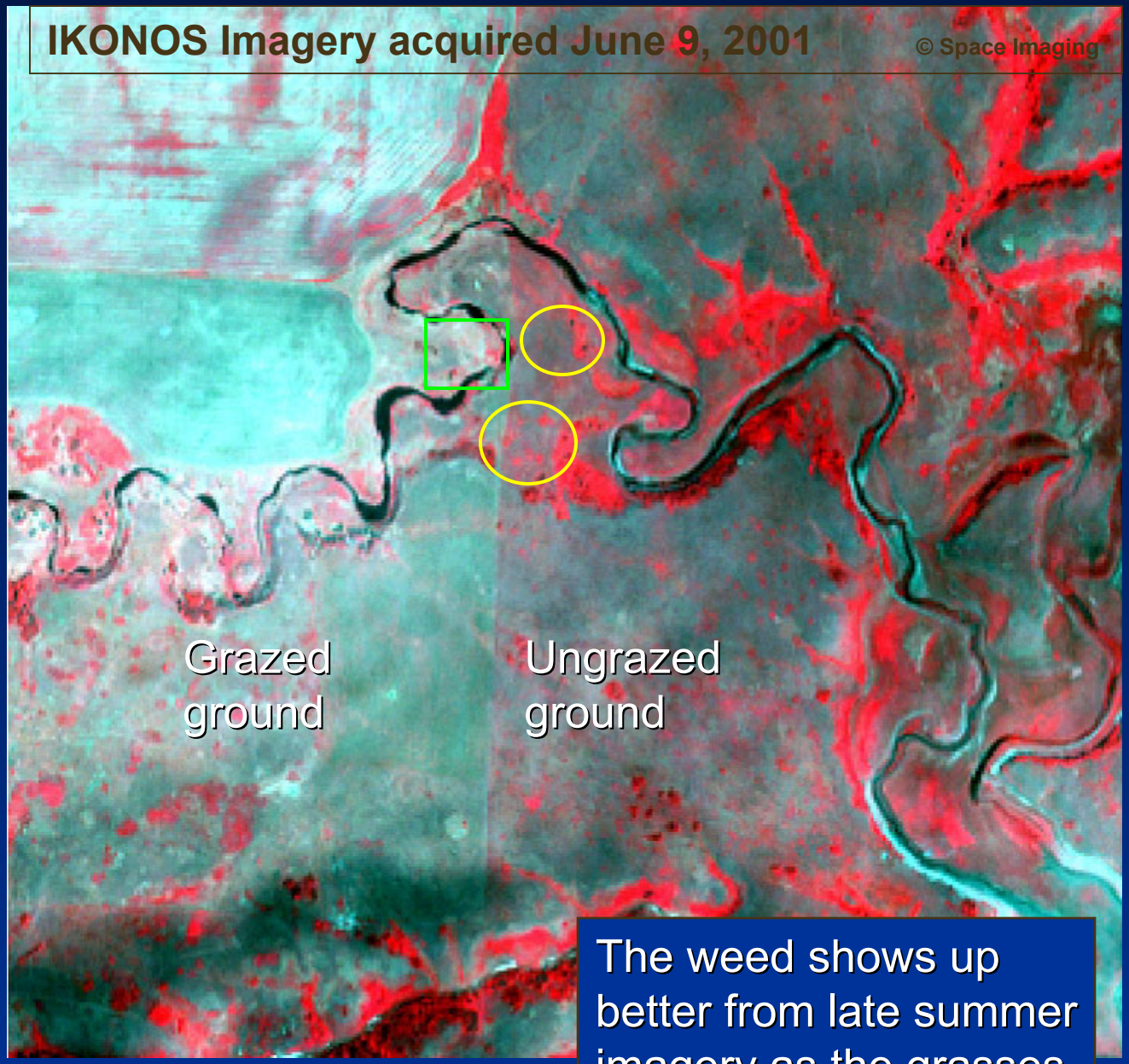
Fort Berthold Indian Reservation





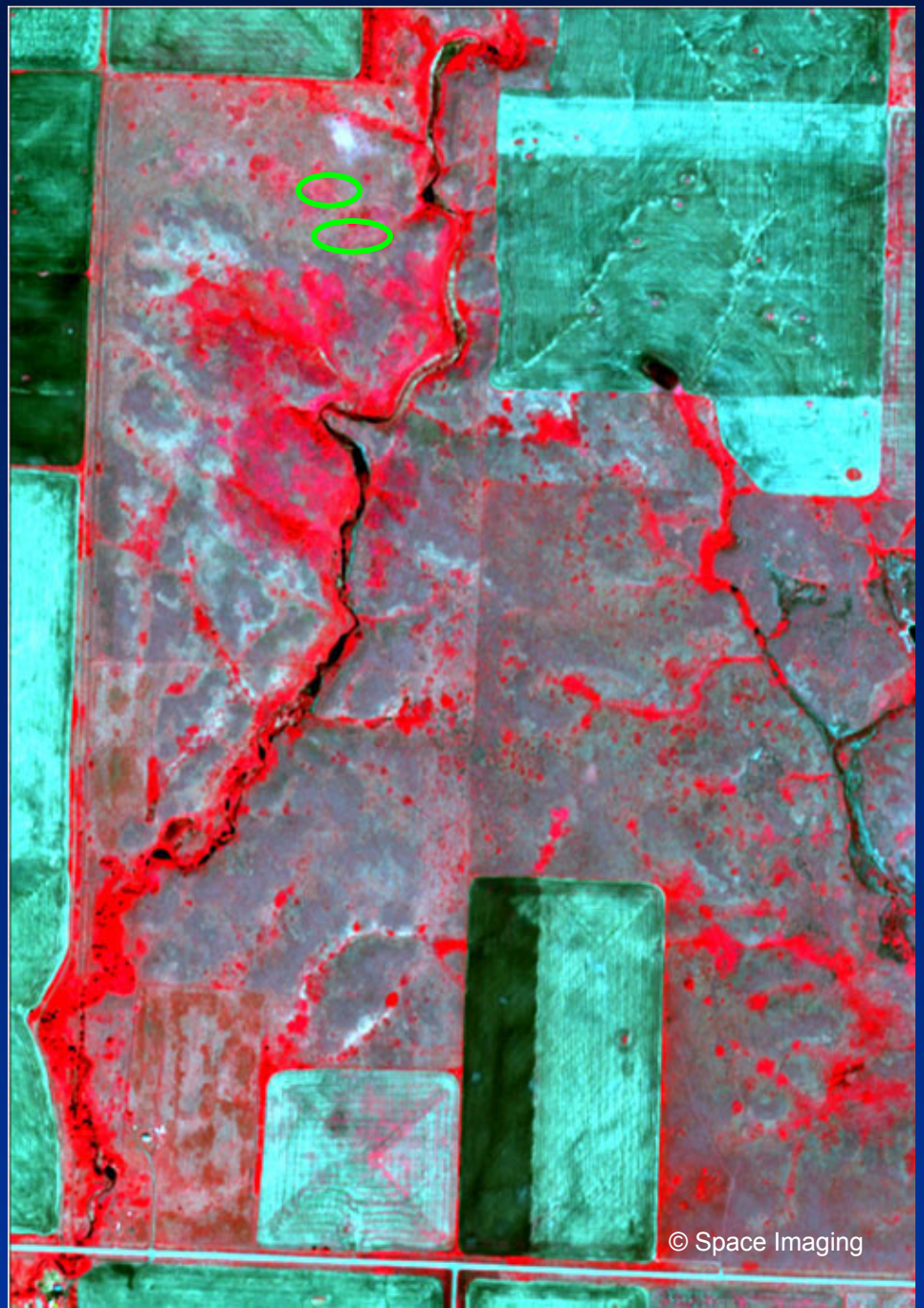
- Locating and monitoring leafy spurge Infestations – ground collected GPS data
- Methods are effective – time intensive, reservation 1600 sq. miles
- Progress is slow – weed spread is fast

- Leafy spurge is mixed with other weeds and grass
- It is easier to identify leafy spurge on the imagery when the percent cover is high
- Cattle graze selectively, leaving behind the weed, making it easier to identify on recently grazed lands
- We visited the field six weeks after the imagery was acquired and the grazing pattern was reversed

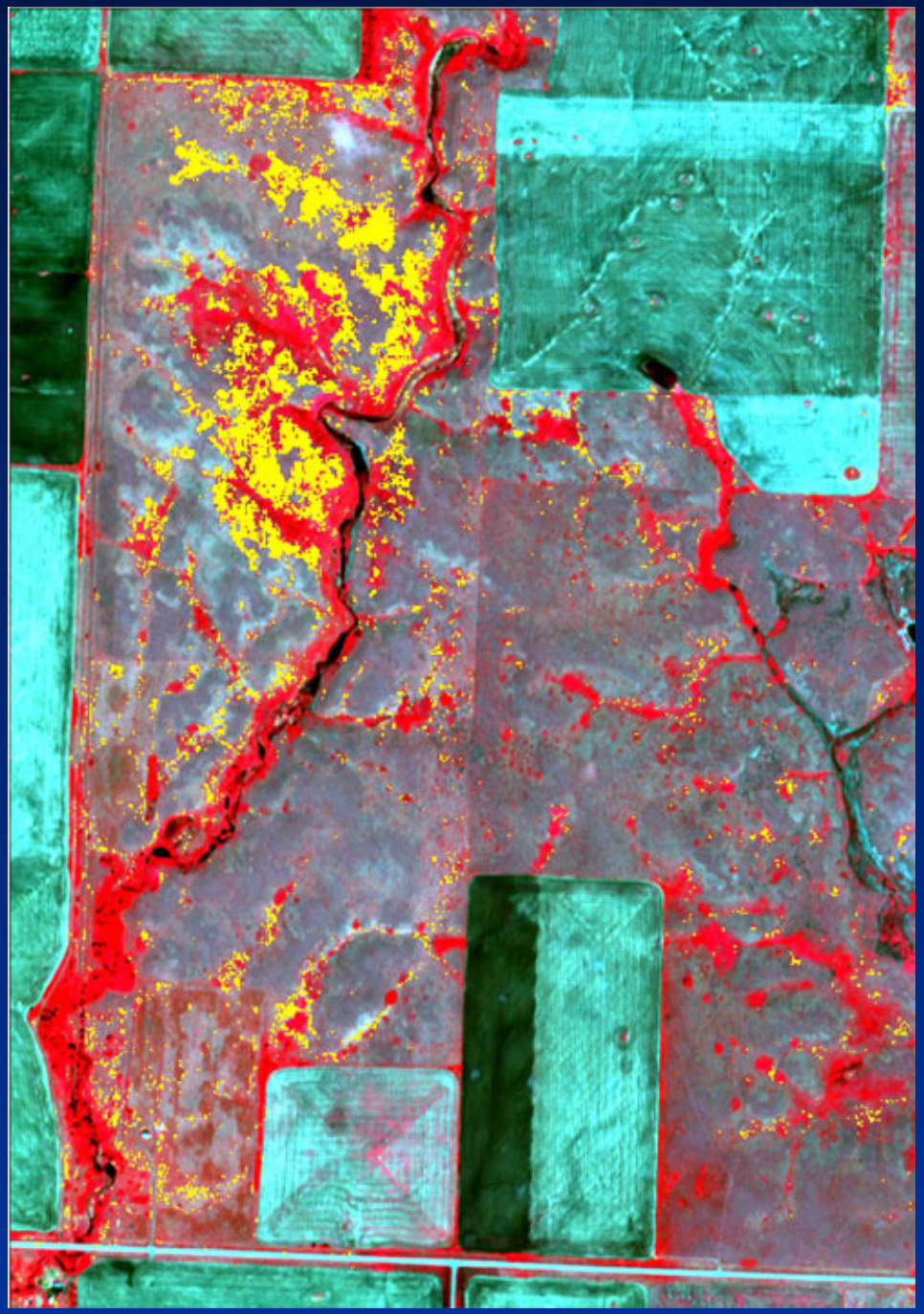


The weed shows up better from late summer imagery as the grasses dry and die

- IKONOS imagery acquired over 3 dates (June 9-July 17, 2001)
- Multidate imagery used to enhanced ability of detecting leafy spurge from surrounding vegetation
- Groundtruth carried out to select training sites for classification
- Homogenous, high percent leafy spurge areas chosen as training sites



- Maximum likelihood classification was run
- Classification (leafy spurge shown in yellow) showed several unknown, new areas of infestation
- Change detection and accuracy assessment planned for this summer



Factors Determining Detection Accuracy

1. Plant growth stage
2. Percent cover of spurge infestation
3. Contrast with background matrix

Other Factors

Spurge shows up especially well in recently grazed areas where other vegetation has been selectively removed

Conclusions
-Remote Sensing-

- Imagery can be used to detect previously unknown infestation site
- Monitor infestations under management regimes
- Remote sensing efforts combined with predictive modeling provides highly effective ways to track leafy spurge over large areas

More Conclusions
-Predictive Modeling-

- Combining remote sensing with predictive modeling can save time of land managers in identifying infestation sites
- Reduces the time that infestations are allowed to spread before being detected and controlled
- Predictive modeling can identify spots where environmental conditions might support leafy spurge infestations
- These areas could be closely monitored to hit leafy spurge outbreaks long before they become severe

Acknowledgments

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